CANADIAN NUCLEAR SOCIETY

bulletin

DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

February 2003 Février

Vol. 24, No. 1

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More history

The Montreal Laboratory

- the conception and birth of the Canadian nuclear program

Almost exactly 60 years ago, in early 1943, a group of British, European and Canadian scientists moved into a new but unused building on the campus of the University of Montreal to begin the work that would lead to NRX, ZEEP, Chalk River Laboratories, and eventually, the full Canadian nuclear program. The project was set up under the National Research Council and was soon called the Montreal Laboratory. Starting from a rudimentary knowledge of fission, behaviour of neutrons, radiation effects, and related matters, the group managed to develop the conceptual design of NRX by late 1944.

To provide some insight to this auspicious but largely unheralded achievement we present an extract from a talk given in 1966 to the Canadian Association of Physicists by George Laurence, at that time President of the Atomic Energy Control Board, who had been the senior Canadian at the Montreal Laboratory.

Laurence was born in1905 in PEI. On a scholarship to Cambridge University in the UK he studied at the Cavendish Laboratory under Lord Rutherford. Returning to Canada in 1931 he joined the National Research Council in Ottawa to head a new division of radiography. Following the discovery of fission in 1939 he, together with Bernard Sargent, over the summers of 1940 -42 and working in their spare time, built a sub-critical assembly of uranium oxide and coke, one of the first such experiments in the world. That work was an important factor in the decision, in 1942, by the British government to move its atomic research to Canada. The British team included a number of scientists who had escaped from the Nazi invasion of 1940 and who had brought heavy water spirited out of Norway just before that country was overcome.

A longer, more formal, paper by Laurence on the same subject entitled "Early Days of Nuclear Energy Research in Canada" was published by Atomic Energy of Canada Limited in 1980.

He began his talk with some reminiscences of his graduate days and then spoke briefly about the sub-critical assembly mentioned above.

We were still doing things by ourselves during those experiments which Dr. Sargent and I did in Ottawa with uranium and petroleum coke. With a few lab assistants, we loaded ten tons of the black powdery petroleum coke into a big bin. We arrived home looking like coal miners just emerging from the pit. We explained to our families that we were doing secret war work.

The neutron detector used in the first measurements was a twenty-five cent piece. Since the half-life of silver 109 is about twenty-four seconds, one had to step lively. The twenty-five cent piece was pulled out of the uranium and carbon lattice precisely on the minute - one rushed across the room to place it in front of the homemade geiger counter (taking care not to poke your finger through the thin glass window of the geiger counter) - and switched on the counting circuit at precisely twenty seconds after the minute. The counting was stopped at precisely one hundred and twenty seconds after the minute. Later we obtained some disprosium and were able to make a more accurate detector of disprosium which, of course, has a much longer half-life.

Many of you remember the Montreal Laboratory - the wartime atomic energy project in Montreal. Some of you will have read about it in one or more of the official histories of the early days of atomic energy development that have been written from different national points of view. At the risk of adding confusion, I thought it might be of interest to recall unofficial impressions of it.

Early in 1942 the British decided that their research effort on atomic energy would be more effective if it were moved to the United States where the supply of equipment and materials was easier and where they could collaborate closely in the American programme. The Americans rejected this proposal. They felt that it was too great a security risk because the senior members of the group that would be sent from Britain were refugees from countries in Europe that were under Nazi domination.

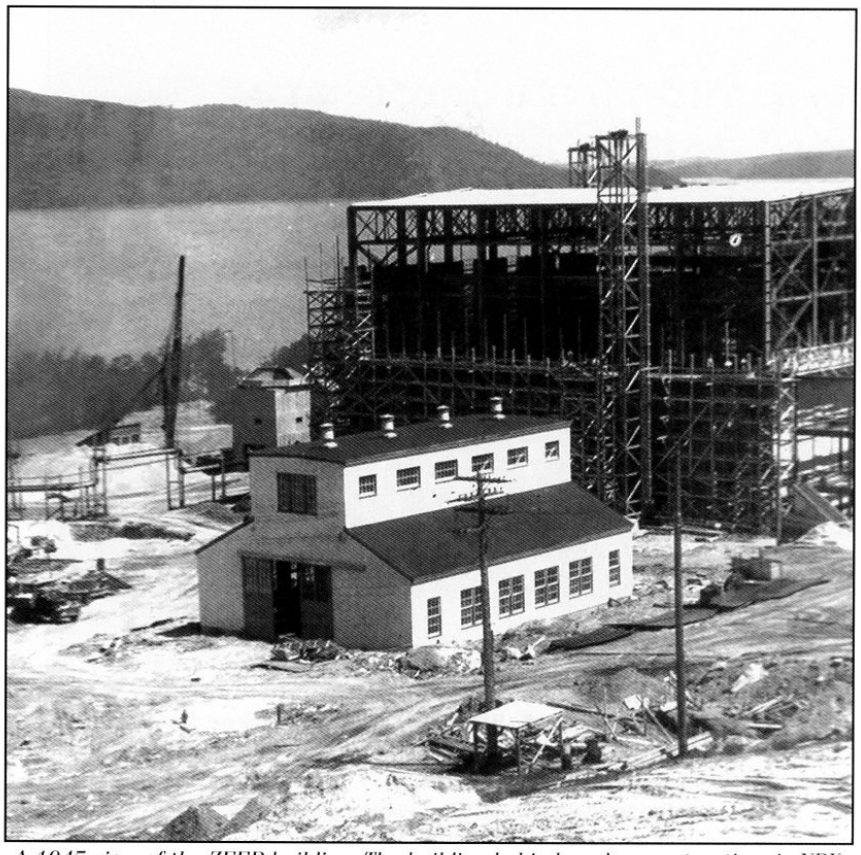
The British then suggested that their team be moved to Canada where they would be closer to the American effort. The Americans could scarcely refuse to accept this arrangement. The proposal for a joint British-American-Canadian atomic energy research project in Canada was put to Dr. C. J.

Mackenzie [president of NRC] and then to the Honourable C. D. Howe [Minister of Munitions and Supply]. On September 2, 1942, Sir John Anderson formally asked for a reply.

The objective was speculative. It was doubtful if it could be completed before the end of the war. It would divert scientists, equipment and facilities from other wartime effort and would commit Canada to the expenditure of many millions of dollars. There would be difficulties in the procurement of materials, particularly the many tons of heavy water.

Dr. Mackenzie said later that the deciding consideration was the thought that when peace was restored atomic energy was bound to have consequences of social and economic significance far beyond the possibilities of imagination and prediction, and that the proposed United Kingdom-Canadian research effort would provide an opportunity for the training of Canadian scientists in this field that should not be missed. So the decision was made.

It was decided that administration of the laboratory would be under the National Research Council. It would be in Montreal, and Hans H. von Halban, who was the leader of the group in Britain, would be the scientific director of the laboratory.



A 1945 view of the ZEEP building. The building behind, under construction, is NRX.

By the end of the year 1942 the first of the British team had arrived from England. It consisted of two Frenchmen, two Germans, one Czechoslovakian, one Austrian, an engineer from Imperial Chemical Industries, and one other Englishman. As temporary quarters, we occupied an old residence, later torn down, at 3470 Simpson Street in Montreal, and as we recruited more staff it became very crowded. The master bedroom served as the director's office while the adjoining bathroom was occupied by his secretary as her office.

Three months later [early 1943] we moved into larger space in the new building of the University of Montreal. Dr. [David] Keys, acting on behalf of the Wartime Bureau of Technical Personnel, helped us in finding Canadian scientists and engineers. More scientists and engineers came from the United Kingdom and the staff grew fairly quickly to over 300.

The project was started in an atmosphere of enthusiasm and expectation of great scientific adventure. Technicians were soon busy making boron chambers to detect neutrons and scaling circuits to count them. Twenty tons of graphite bars were obtained and Dr. Sargent and other physicists were measuring the penetration of neutrons through that material. A two million volt X-ray machine was purchased and its rays, by bombarding beryllium, provided a source of neutrons for experiments in the graphite.

About one hundred kilograms of heavy water arrived from England. It was a major part of the world supply at that time which the French scientists von Halban and Lew Kowarski were able to get out of France before it was overrun by the Germans. This was a precious treasure. Great care was taken to avoid loss of even minute quantities by evaporation. Drips were carefully wiped up with hospital cotton which was then sealed in vapour-tight containers so that the heavy water could be recovered.

The theoretical physicists, among them George Volkoff and other Canadians, were busy developing mathematical methods for the calculation of the behaviour of neutrons in an atomic reactor. The chemical properties of uranium, neptunium and Plutonium were being investigated and efforts were made to develop a corrosion resistant alloy of uranium. The biological effects and the hazards of radiation were being studied.

Various kinds of reactors were discussed and considered. One proposal was that the uranium should be in the form of a slurry in heavy water. I remember footprints down a corridor - yellow footprints. Someone had spilled some "mayonnaise" and stepped in it. "Mayonnaise" was the

This rare photograph from the Montreal Laboratory shows mostly members of the Physics Division in late 1943.
Counter clockwise from front left: Warwick Knowles, Dr. Pierre Demers, James Leicester, Dr. Henry Seligmann, Ernst Courant, Ted Hinks, Fred Penning, Dr. Bruno Pontecorvo, Dr. George Volkoff, Dr. G. Placzek, (U.S. Liaison Officer), Dr. Allan Nunn May, Quenton Lawrence, Stefan Bauer, Dr. George Laurence, Dr. Pierre Auger, Dr. (Sir) John Cockcroft, Frank Jackson, Newell, Dr. H. Von Halban, H.F. Freundlich, Dr. Jules Gueron (Chemistry Division), Gordon A.R. Graham, Dr. B.W. Sargent, John Ozeroff, Dr. Bertrand Goldschmidt (Chemistry Division), Alan Munn

laboratory jargon for a slurry of uranyl nitrate in water. That was before there were any regulations about radioactivity contamination.

Soon we became impatient as we waited for the close collaboration with the Americans to become established. The Americans were still worried about safety and the very mixed national background of our team. They made counter proposals for a limited cooperation for the exchange of information restricted to certain aspects of the work only. In particular they excluded information on the chemical extraction of plutonium on the grounds that the supply of this information to Montreal would not in any way contribute to the war effort at that time. They would agree that certain British scientists of outstanding reputation, such as Oliphant, could work in the United states on certain specific aspects of the undertaking, but their travel would be restricted and they would not meet with certain senior United States scientists.

The British felt that the attitude of the Americans was unfair and somewhat insulting. This British reaction was not understood in the United States and the Americans seemed to be offended when their proposal was not accepted. To Canadians it seemed particularly frustrating and tragic that there should be such poor understanding between the British and the Americans.

Meanwhile the Montreal Laboratory was cut off from information about the atomic energy work in the United States. This was in contrast to the easier correspondence that had existed before. In 1941 I had visited Columbia University where I talked to Fermi, Compton and Pegram, who described their sub-critical experiments with graphite blocks and uranium, and to Urey who discussed the production of heavy water and the separation of U-235. In Washington I talked to Dr. Briggs, the chairman of the committee that was then coordinating the atomic energy research in the United States. In 1941 and 1942 we obtained secret reports of the American work without difficulty.

Our Director was of a family that might be described as belonging to the lesser nobility in Austria. He had come to Canada happy in the expectation that it would be much easier to secure materials and supplies for the laboratory than it had been in Britain under the blitz. However, in 1943, supply in North America was becoming difficult. I can remember angry phone calls to Ottawa to the National Research Council's Purchasing Department. Where was his waste basket? It was to have been delivered weeks ago.

von Halban was not accustomed to Canadian business methods. The administrative staff in Ottawa was equally unaccustomed to the Austrian lesser nobility. They spoke of the Montreal Laboratory as a madhouse - not an ordinary madhouse, but one that was run by the inmates.

The Director's criticism of the Purchasing and other administrative divisions of the National Research Council in Ottawa was echoed by some of the other staff members from abroad who were not really in a position to know, and has some reflection in one of the official histories. This is most regrettable because it was unjust to a very capable staff that worked hard to provide a service to the Montreal Laboratory in spite of the demands on their energies of other war work that was more urgent and more important.

In the beginning it was intended that the scientific programme of the laboratory should be planned by a committee known under the code name of the Technical Committee on Radiological Protection. The committee soon ceased to meet and I, as the only Canadian on it, was left more and more in the dark about what was being planned. This was just another aspect of the difficult relations between the scientific direction of the laboratory and the National Research Council.

[British Prime Minister Winston] Churchill discussed the

very unsatisfactory state of British-American collaboration in atomic energy with [US President Franklin D.] Roosevelt at the Quebec Conference. On August 19, 1943, they agreed on behalf of their governments that arrangements would be made "to ensure the full and effective collaboration between the two countries in bringing the project to fruition."

Notwithstanding this, months passed without progress towards effective collaboration. The morale of the Montreal Laboratory sank very low.

It was generally believed by the Montreal scientists that it was General Groves, who had charge of the whole American effort [Manhattan Project], that was responsible for the delays. It seems clear now that it was senior American scientists, Vannevar Bush and J. B. Conant, that dragged their heels. Both in the United Kingdom and the United States the situation was worsened by poor communication between heads of state, officials and scientists, and it resulted in errors in judgment and misunderstandings between the two countries. By the end of 1943 the usefulness - at least for Canada - of continuing to operate the laboratory was questioned. There appeared to be too little point in it unless effective collaboration could be established.

Those who played leading parts in the negotiations at this time were General Groves, Professor [Sir James] Chadwick and Dr. Mackenzie. Groves and Chadwick were men of very different backgrounds and temperament: one a blunt soldier and tough administrator; the other, as you know, a sensitive scientist. Yet, evidently a mutual respect and confidence had grown between them. This factor, as well as the good sense of the three men, made it possible at length to bring about cooperation and thus to save the Montreal Laboratory.

John Cockcroft was persuaded to become Director of the laboratory and it was agreed that the alien members of the staff should leave. It was agreed to proceed at once with a heavy water moderated reactor plant in Canada, The atmosphere changed quickly. The Americans then whole heartedly supported the project. Scientific information, essential supplies and help in many ways came from the United States and visits were arranged for senior Montreal scientists to the American projects.

Defence Industries Limited was engaged to do the engineering design of the laboratories, reactors, services, and the townsite. Fraser-Brace Limited would do the construction. A much less powerful reactor, which became known as "ZEEP" was built first to test certain features of the design of the larger reactor NRX.. Under Cockroft's direction, administration became less difficult and a sense of purpose was restored to the Montreal Laboratory. As laboratories were built in Chalk River and houses for the staff in Deep River, the Montreal Laboratory was gradually closed down.

Secrecy was an important feature of the whole activity with great precautions for the care of documents and detailed instructions to the staff regarding what they might discuss with their colleagues in other divisions of the laboratory, and what they might write on blackboards that were opposite windows. It sometimes was carried to childish extremes. For example, in chemical formulas uranium was represented by the letter X.

On one occasion we received a visit from the United States by a Mr. Baker. Senior members of the staff and their wives were entertained at Cockcroft's home. All evening we chatted with Mr. Baker, solemnly addressing him by that name, but knowing all the time that he was Neils Boar.

In spite of the administrative difficulties, the lack of clearly defined objectives, and the sense of disappointment and frustration during the period of about a year, the scientists in the Montreal Laboratory maintained a very high standard in their research.

I would like to mention the names of some of the Canadian physicists who participated in this work.

Jeanne L. Agnew; D. S. Craig; p. Demers; D. G. Douglas; L. 0. Elliott; S. C. Fultz; Q. A. Graham; E. Guptill; T. J. Hardwick; E. P. Hincks; D. 0. Hurst; D. Kirkwood; W. J. Knowles; S. A. Kushneriuk; M. W. Lister; J. C. Mark; A. M. Munn; J. W. Ozeroff; B. W. Sargent; J. D. Stewart; Miss A. Underhill; D. Van Patter; E. B. Paul; 0. M. Volkoff; P. R. Wallace; W. H. Walker; A. 0. Ward.

In addition, the following, who were members of the British staff in Montreal, became Canadian residents:

C. B. Amphlett; H. Carmichael; B. Davison; K. D. George; R. G. Hanna; J. F. Steljes; J. B. Warren; C. H. Westcott.

Besides those whose names I have read, there were, of course, the physicists from other countries and the specialists in other sciences and engineering. Never before in Canada had so large a group of scientists of different disciplines been brought together for a single purpose.

Their work in the Montreal Laboratory was mostly applied research but the background of most of them was fundamental research. Canada's atomic energy had its origin in fundamental science, and, through wise direction at Chalk River, fundamental science has continued to inspire and stimulate it.

Never before has the Government of Canada supported so strongly a specific programme of research and development. The consequential growth of our nuclear industry is one of the factors that has brought about a growing realization that strong support of research is essential in a country that aspires to compete as a manufacturing nation in the commerce of the world.

The Montreal Laboratory and the research and development that has since grown from it have brought Canada recognition as one of the pioneer nations in atomic energy, have given greater authority to Canadian opinion in international relations, and have opened greater opportunities for us in industry and commerce. The Montreal Laboratory is deserving of mention in the history of science in Canada.